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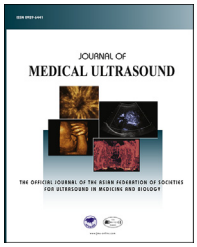

CASE REPORT

Pneumocardium Captured on Bedside Transesophageal Echocardiography—An Unreported Complication of Needle Thoracostomy

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Abstract We describe a case of left-sided pneumocardium, identified by transesophageal echocardiography, following needle thoracostomy in a tertiary intensive care unit (ICU). Bilateral needle thoracostomy was performed during a cardiac arrest. Intracardiac arrest echocardiography demonstrated pneumocardium immediately following the procedure, with air in the left atrium (LA) and left ventricle (LV). This previously unreported consequence of needle decompression contributes to a growing body of literature that questions the value of this intervention.

Introduction

Tension pneumothorax is a serious condition with high lethality which has prompted decades of support for empiric needle thoracostomy (NT) when clinical suspicion is high [1]. Traditional technique endorses NT to be performed with a 14-gauge intravenous catheter needle in the second intercostal space at the midclavicular line (2nd ICS MCL). Lending support to existing challenges to the effectiveness of this technique [2], we present a case of a patient with left-sided pneumocardium captured on bedside transesophageal echocardiogram after NT.

Case Report

A 65-year-old female belted driver of an SUV was struck by a truck at highway speeds. The woman had a past medical history of Sheehan syndrome, hypertension, and

Conflicts of interest: Dr. Arntfield has served as an educational consultant for Fujifilm Sonosite Inc. All other authors have no competing interests.

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osteoporosis. After prolonged extrication, she was resuscitated, stabilized, and imaged at a trauma center. Her injuries included diffuse axonal injury, facial fractures, right arm degloving, an open left femur fracture, and fractures of her left ankle, tibia, and hand. She was admitted to the intensive care unit (ICU) and supported with mechanical ventilation in between multiple surgeries, including internal fixation of her left femoral fracture. While initially stable after trauma resuscitation, her hemodynamic status became unstable on postadmission Day 3 following operations for her ankle and soft tissue injuries. With a presumptive diagnosis of sepsis from open wounds, antibiotics were initiated and vasopressor infusions were used to successfully stabilize her blood pressure. A transthoracic echocardiogram performed at that time demonstrated a hyperdynamic left ventricle (LV) and no evidence of intracardiac air.

On postadmission Day 4, our patient experienced a sudden, refractory hypoxic event causing cardiac arrest with pulseless electrical activity (PEA). Cardiopulmonary resuscitative measures were immediately initiated by the ICU team. Among the chief concerns for her demise was a tension pneumothorax from barotrauma. Bilateral needle decompression of the pleural spaces was done with 14-gauge, 5-cm angiocatheters in the 2nd ICS MCL, per traditional technique. There was no gush of air for either needle, with a trace amount of blood from the left needle noted. Concern for pulmonary laceration and/or creation of pneumothorax prompted bilateral tube thoracostomy while resuscitation continued. These were inserted without difficulty and with no appreciable gush of air or blood Because of persistent PEA, the team performed an intra-arrest transesophageal echocardiogram (TEE) to evaluate for reversible cardiac causes and guide resuscitative efforts.

The TEE demonstrated a normal right ventricular size (making catastrophic pulmonary embolism unlikely) and no pericardial effusion. However, images obtained during a pulse-check from the midesophageal four-chamber view demonstrated small hyperechoic densities, consistent with air, moving from the left atrium (LA) to the LV (Figure 1, Videos S1 and S2). At no point was air identified in the right heart. Unfortunately, no return of circulation ever occurred and the patient was pronounced dead after more than 30 minutes of cardiac arrest. The underlying cause of the hypoxia was determined to be fat embolism from extensive orthopaedic trauma.

Supplementary video related to this article can be found at http://dx.doi.org/10.1016/j.jmu.2016.07.004

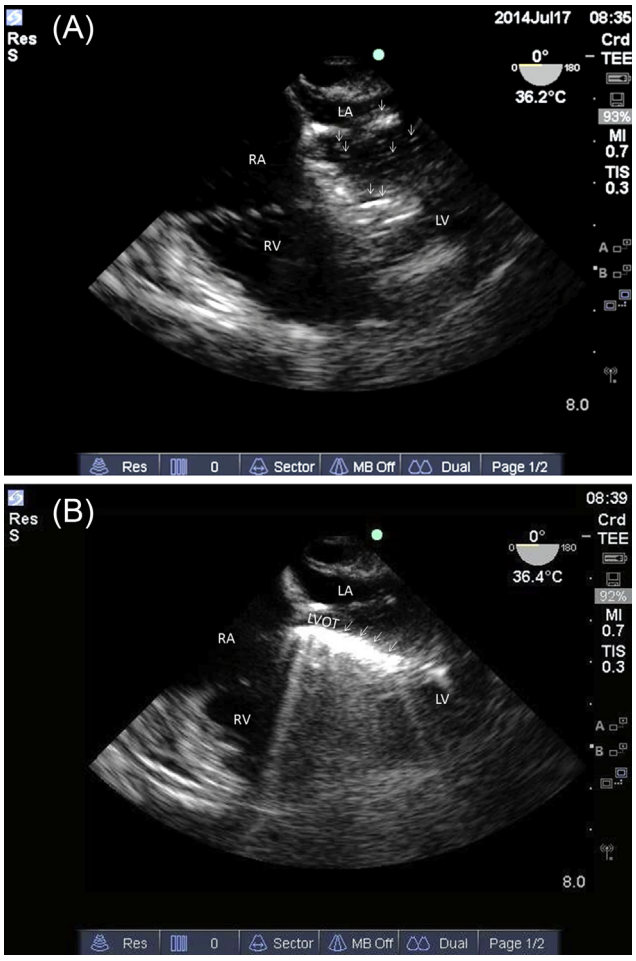

Figure 1 Intra-arrest transesophageal echocardiography images. (A) Midesophageal four-chamber view showing small and large reflections inside LV (arrows); (B) repeat midesophageal four-chamber view minutes later showing dense accumulation of air (arrows) along LVOT. LA = left atrium; LV = left ventricle; LVOT = left ventricular outflow tract; RA = right atrium; RV = right ventricle.

Discussion

Presented with TEE images of air passing through the LA into the LV during agonal contractions of a pulse check, we were tasked with explaining this unexpected finding. Trace amounts of air from IV tubing may commonly enter the right ventricle and be seen on echocardiography. Air completely reflects ultrasound and, in a fluid-filled chamber, produces a characteristic appearance of bright, hyperechoic granules (Figure 2). This same finding in the LV is pathological and is typically due to an intracardiac or intrapulmonary shunt (Figure 3).

We posit that air arriving in the LV began with puncture of the pulmonary venous network by angiocatheter placement. As CPR resumed, the pressure gradient from thoracic cage recoil entrained air into this venous system. Further compressions mechanically advanced the air to the LA and LV, where it was detected by TEE. Our patient's postmortem excluded pre-existing structural defects capable of producing left-sided pneumocardium, including ventricular or atrial septal defect. There was no history of liver disease (hepato-pulmonary syndrome) or arteriovenous malformations (computerized tomography scan of the thorax with contrast on hospital admission) to support an intrapulmonary shunt.

Left-sided pneumocardium, though uncommonly noted, was reported from a similar mechanism by Frank et al in 2014 [3]. They described a case of left-sided pneumocardium and cardiac arrest in a patient following thoracic needle biopsy, where air entry occurred from a fistula between the pulmonary vein and a small bronchus or alveolus.

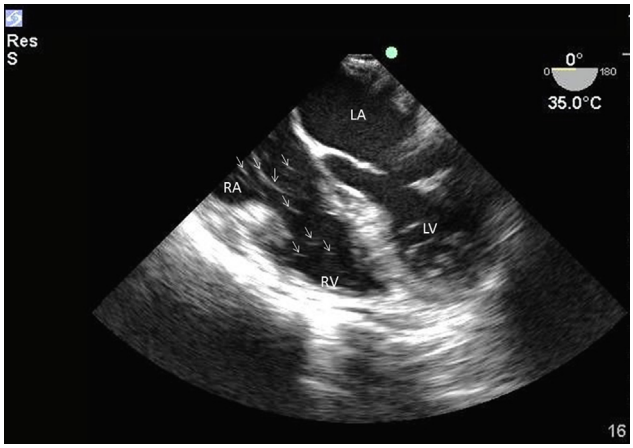

Figure 2 Midesophageal four-chamber view demonstrating normal air artifact (arrows) commonly seen in RV from microbubbles contained in fluids and/or tubing. LA = left atrium; LV = left ventricle; RA = right atrium; RV = right ventricle.

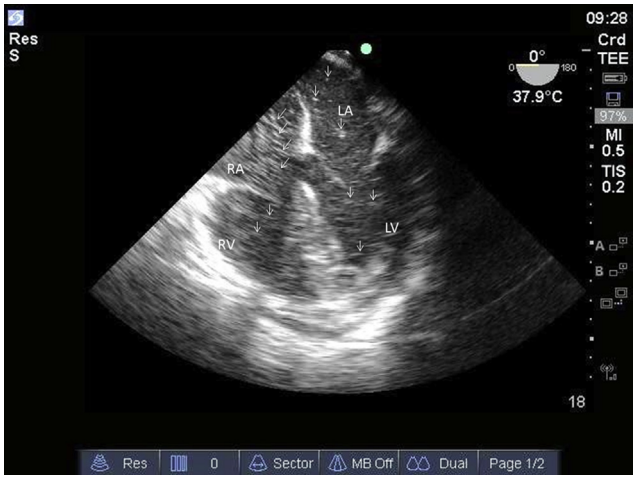

Figure 3 Midesophageal four-chamber view demonstrating pathologic right-to-left cardiac shunt due to patent foramen ovale. Bright white air artifacts (arrows) throughout all four chambers of the heart. LA = left atrium; LV = left ventricle; RA = right atrium; RV = right ventricle.

The high lethality of cardiac arrest is commonly used to justify empiric treatments and procedures. In such scenarios a "nothing to lose" mentality and/or anecdotes of similar life-saving interventions may contribute to aggressive empiric actions. With our finding of left-sided pneumocardium, we submit that without strong clinical evidence to support pneumothorax, such as hypoxemic cardiac arrest or sudden changes in lung compliance, empiric, traditional NT (in the MCL) for cardiac arrest in the ICU should be discouraged. Pneumocardium poses significant concerns for worsening cardiac and neurologic outcome in this already high-risk circumstance. Of note, the use of lung ultrasonography directed at identifying lung sliding may serve as a useful and highly accurate tool to rule out pneumothorax, further reducing the need for NT in an empiric fashion [4].

Our finding of morbidity in the setting of needle decompression joins a growing body of literature expressing concerns regarding this procedure. In a case series, a common complication of needle thoracostomy was failure to drain the pleural space [2]. Reasons for this may be multifactorial, but ultimately a mismatch between chest wall size and needle length has been proposed [5]. Other case reports of important complications from needle thoracostomy, including lung injury, hemorrhage and pericardial tamponade [6], lend further support to a critical view on the value of this procedure when alternative methods are available.

Alternative considerations to NT include a lateral approach to needle decompression (where studies suggest the chest wall is less thick) [7], finger thoracostomy [8], and tube thoracostomy.

Conclusion

We present a case of left-sided pneumocardium following empiric anterior NT during cardiac arrest. Our case joins a growing body of work that suggests this procedure confers high risk to patients with low success rates. Despite the additional time required, alternative techniques of managing tension pneumothorax, including lateral chest wall NT, finger thoracostomy, or traditional tube thoracostomy, should be considered.

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